



## **ADDRESSING TRANSBOUNDARY ENVIRONMENTAL HARM THROUGH TECHNOLOGY: MITIGATING THE TRAGEDY OF THE COMMONS IN GLOBAL RESOURCE MANAGEMENT**

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### **Abstract**

*Transboundary environmental harm—including pollution, deforestation, biodiversity loss, and climate change—has become a critical global concern, escalating despite widespread awareness and numerous policy interventions. This paper evaluates the relationship between transboundary environmental harm, the tragedy of the commons, and the mitigating potential of technological innovation in global environmental governance. Using case studies, the research examines how technological tools such as remote sensing and AI-driven environmental modelling have been deployed to monitor, manage, and prevent cross-border ecological degradation. Employing a qualitative research methodology, the study finds that the persistence of the tragedy of the commons in transboundary contexts is largely due to weak enforcement mechanisms and conflicting national interests. However, technology has demonstrated promise in fostering transparency, accountability, and cooperative decision-making through real-time data sharing and independent monitoring, thus reducing information asymmetry among states. While technology alone cannot resolve transboundary environmental challenges, this paper argues that, when integrated with robust governance frameworks and strengthened multilateral cooperation, it can significantly contribute to sustainable and equitable resource management. The paper concludes by recommending greater investment in shared technological platforms and the establishment of binding regional protocols to enhance collective environmental stewardship.*

**Key Words:** Transboundary, Environmental Harm, Global Resource Management, Tragedy, Commons

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## 1.0. INTRODUCTION

“The most rapidly growing populations on earth today are (in general) the most miserable.”<sup>1</sup>

The book, “The Tragedy of the Commons” authored by Garrett Hardin, is credited for highlighting the very urgent need to address the imminent fear that commonly owned resources (whether natural or non-natural) could be exhausted if measures are not put in place to address their indiscriminate use.<sup>2</sup> Describing this tragedy in the loose sense connotes an exhaustion of these commonly owned resources, a tragedy which the author has famously described as “the tragedy of the commons.”<sup>3</sup> It must be noted that overtime, transboundary pressures have occurred constantly putting pressure on the environment due to human activities with transboundary effects these have no doubt consequently given rise to issues on the definition of the limits “which transcend beyond the extent of the relevance of these transboundary deleterious effects in relation to international law.”<sup>4</sup>

The 21<sup>st</sup> Century has witnessed an intensification of transboundary environmental challenges that transcend national borders and threaten the sustainability of ecosystems and human livelihoods alike.<sup>5</sup> From the relentless advance of climate change and the degradation of shared water bodies, to transboundary air pollution and the deforestation of ecologically critical zones, it is clear that environmental harm is no longer confined within or restricted to the territorial limits of individual states.<sup>6</sup> Environmental harm has thus transcended from being a knotty domestic issue to one of grave international concern. This complex reality has increasingly rendered traditional, state-centric environmental governance approaches and policies inadequate, thus exacerbating transboundary environmental harm. Compounding the difficulty of addressing such harm is the phenomenon known as the “tragedy of the commons,” wherein the absence of clear ownership and effective collective stewardship of shared resources leads to overexploitation and environmental degradation.

Garrett Hardin’s article “Tragedy of the Commons” sought to highlight the fundamentals of tackling population problems through different solutions, solutions which he described as non-technical.<sup>7</sup> The technical solution proposed by Hardin is to ensure solutions to overpopulation and its evils and at the same time enjoy the benefits of population.<sup>8</sup> The author had suggested the increase in resources without limit in a limited world.<sup>9</sup> The idea that resources should be held in common has unfortunately signalled the possibilities of over-exploitation of those resources.<sup>10</sup> In relation to population and the environment, Hardin’s use of the metaphor of a

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<sup>1</sup> Garrett Hardin, *The Tragedy of the Commons*, 162 (3859), 1968, 1244

<sup>2</sup> Garrett Hardin, *Ibid* at 1244

<sup>3</sup> Garrett Hardin, *Ibid* at 1244

<sup>4</sup> Kamen Sachariew, *The Definition of Thresholds of Tolerance for Transboundary Environmental Injury Under International Law: Development and Present Status*, *Netherlands International Law Review*, 2009, 193

<sup>5</sup> Girma Defere, Messay Mulugeta and Teferi Tolera, *The Need for Transboundary Natural Resource Management and Adaptation for Environmental Sustainability and Human Well-being in the Ethiopia-Kenya Borderland*, *GeoJournal* 89, 78 (2004) available at <https://doi.org/10.1007/s1078-024-11066-x>

<sup>6</sup> Gunther Handl, *International Accountability for Transboundary Environmental Harm Revisited: What Role for ‘State Liability’?* 37 *Envtl. Pol’y & L.* 116 (2007)

<sup>7</sup> Garrett Hardin *Ibid* at 1243

<sup>8</sup> Garrett Hardin *Ibid* at 1243

<sup>9</sup> Garrett Hardin *Ibid* at 1246

<sup>10</sup> F. Berkes, D. Feeny, B.J McCay and J.M Anderson, *The Benefits of the Commons*, *Commentary, Nature*, Vol. 340, 13 July 1989, 91



village in which every herdsman has no choice (as a result of the system) but to increase his herd limitlessly could indeed ensure a limitation of the available resources to the detriment of others.<sup>11</sup> In that sense, it is suggested that there is a wide gulf between individual and collective rationality (the former which Hardin believes does not exist) and thus calls for the need for government controls or privatization.<sup>12</sup> It must however be noted that Hardin quite curiously did not consider the capabilities of man to self-regulate and this is because it proceeds on the assumption that the herdsmen are incapable of limiting access or incapable of instituting rules to ensure the regulation of the use.<sup>13</sup>

In transboundary contexts particularly with regard to environmental law, the tragedy of the commons is especially pronounced. Sovereign states often prioritize short-term national interests over long-term collective well-being, thereby weakening the enforcement of international environmental agreements.<sup>14</sup> The lack of effective accountability mechanisms, divergent regulatory frameworks, and asymmetrical access to environmental data have brought to the fore the need for a collective coordinated action.<sup>15</sup> There have been calls for “a new collaborative environmental governance, an enterprise that involves collaboration between a diversity of private, public and non-governmental stakeholders who, acting together towards commonly agreed goals, hope to achieve far more collectively, than individually.”<sup>16</sup> As a result, despite the proliferation of international treaties, conventions, and summits aimed at fostering global environmental cooperation, the pace of ecological deterioration remains alarmingly high.<sup>17</sup>

Amidst these complexities, technology has emerged as a potentially transformative tool in the quest to address transboundary environmental harm.<sup>18</sup> In recent times, technology has proven to be a useful tool in different spheres of human endeavours.<sup>19</sup> Innovations in remote sensing, satellite monitoring, artificial intelligence (AI), blockchain, and data analytics offer new avenues for transparency, accountability, and real-time monitoring of environmental phenomena that were previously difficult to detect or regulate across borders and these technologies have indeed helped in reducing information asymmetry between nations, facilitate

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<sup>11</sup> Garrett Hardin Ibid at 1247

<sup>12</sup> F. Berkes, D. Feeny, B.J McCay and J.M Anderson, Ibid at 92

<sup>13</sup> F. Berkes, D. Feeny, B.J McCay and J.M Anderson Ibid at 93

<sup>14</sup> Maria L. Banda, Regime Congruence: Rethinking the Scope of State Responsibility for Transboundary Environmental Har, 103 Minn. L. Rec, 1879 (2018-2019)

<sup>15</sup> Neil Gunningham, The New Collaborative Environmental Governance: The Localization of Regulation, Journal of Law and Society, Vol.36, 2009; Hongtao Yi, et al, Regional Governance and Institutional Collective Action for Environmental Sustainability, Public Administration Review, 2018, 556; Orjan Bodin, Collaborative Environmental Governance: Achieving Collective Action in Social-Ecological Systems, Science, Vol.357, No. 6352, 2017

<sup>16</sup> Neil Gunningham, Ibid

<sup>17</sup> Maria L. Banda, Ibid

<sup>18</sup> Florian Rabitz, Transformative Novel Technologies and Global Environmental Governance, Cambridge University Press, 2023.

<sup>19</sup> Ikubanni Oluwaseye and Adeboye Oluwaseye Thompson, Covid-19 and the Growth of Telemedicine in Nigeria: Prospect, Legal Issues and Challenges as Means of Access to Justice in Nigeria: A Comparative Study. DiH Jurnal Ilmu Hukum, 2025; Ikubanni Oluwaseye and Adeboye Oluwaseye Thompson Live Telecast of Judicial Proceedings Jurnal Hukum Magnum Opus 8 (2), 2025



evidence-based policy-making, and support collaborative resource management strategies by providing verifiable, up-to-date data.<sup>20</sup>

There is thus a pertinent need to evaluate the connection and/or relationship between transboundary environmental harm, the tragedy of the commons, and the role of technology in mitigating environmental degradation in global contexts. Using few case studies, this paper interrogates how technological solutions have been or could be employed to enhance environmental monitoring, foster cooperative behaviour, and support more sustainable governance of shared resources in order to avoid an imminent tragedy of the commons. While it must be conceded that technology alone cannot resolve the underlying political and structural impediments to effective global environmental governance,<sup>21</sup> it can operate as an enabling mechanism when coupled with robust institutional frameworks and genuine multilateral cooperation to address transboundary environmental harm.

## 2.0 TRANSBOUNDARY ENVIRONMENTAL HARM

Transboundary environmental harm refers to environmental damage that originates in the territory of one state and causes detrimental effects in the territory of another.<sup>22</sup> Such harm can take multiple forms—air and water pollution, deforestation, biodiversity loss, and greenhouse gas emissions—all of which can transcend national jurisdictions.<sup>23</sup> This type of harm raises complex legal, political, and ethical questions about state responsibility, sovereignty, and the global commons.<sup>24</sup> Transboundary harm is governed by principles such as "no harm" and "good neighbourliness", enshrined in international environmental law, particularly in documents such as the Stockholm Declaration, 1972 and the Rio Declaration, 1992.<sup>25</sup> Transboundary environmental harm is such that it could cause strife between two or more states as a state has the right under international law to seek protection and in other cases, reparations for any transboundary environmental harm which is caused by another state.<sup>26</sup> This right has been argued to be first articulated by the US in the 1930s against Canada on allegations of air pollution.<sup>27</sup>

Transboundary environmental harm refers to environmental damage that originates in one country but adversely affects another, crossing political or geographical boundaries<sup>28</sup> This concept is central to international environmental law, as it challenges traditional notions of

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<sup>20</sup> Florian Rabitz, *Ibid.* Andre Nolkaemper, Cluster-Litigation in Cases of Transboundary Environmental Harm, *International Environmental Law and Conventions*, in Michael Faure and Song Ying (eds) *China and International Environmental Liability, Legal Remedies for Transboundary Pollution*, New Horizons in Environmental Law, Edward Elgar, USA

<sup>21</sup> Victor Galaz, *Global Environmental Governance, Technology and Politics: The Anthropocene Gap*, EE, Elgar Online, 2014

<sup>22</sup> Rene Lefeber *Transboundary Environmental Interference and the Origin of State Liability*, Kluwer Law International, 1996.

<sup>23</sup> Rene Lefeber, *Ibid*

<sup>24</sup> Rene Lefeber, *Ibid*

<sup>25</sup> Allan Rosas, *Issues of State Liability for Transboundary Environmental Damage*, 60 *Nordic J., Int'L L.*, 1991, 29

<sup>26</sup> Maria L. Banda, *Ibid* at 1881

<sup>27</sup> *Trail Smelter (US v Can) Award*, 3 R.I.A.A 1905 (1941) See *infra* Part IV.A; Russell A. Miller, *Transboundary Harm in International Law: Lessons from the Trail Smelter Arbitration*, Washington and Lee Public Studies Research Paper Series, 2011, 1

<sup>28</sup> Birnie, P., Boyle, A., & Redgwell, C., *International Law and the Environment* (3rd ed.). Oxford University Press, 2009



state sovereignty while demanding cooperative governance to mitigate ecological and human health impacts.<sup>29</sup> The key element of transboundary environmental harm include cross-border impact as it connotes harm transcending national borders, affecting air, water, soil, or biodiversity in another state,<sup>30</sup> jurisdictional disconnect as the source state and affected state operate under separate legal regimes, complicating accountability;<sup>31</sup>

Principle 21 of the Stockholm Declaration, 1972 provides that "States have the sovereign right to exploit their own resources, but must ensure activities do not damage other states' environments." Similarly, in the Trail Smelter case<sup>32</sup> which signalled unarguably the first formal recognition of transboundary environmental harm in international law wherein it was held that "no state has the right to use its territory in a manner causing injury in another." Principle 2 of the Rio Declaration, 1992 further reiterates Principle 21 of the Stockholm Declaration and emphasizes due diligence to prevent harm.<sup>33</sup>

### 3.0 TRANSBOUNDARY ENVIRONMENTAL HARMS AND ROLES OF INTERNATIONAL LEGAL REGIMES IN ITS PREVENTION

Transboundary environmental harm has no doubt, been a recurring problem in international law and as such, the obligation to ensure the prevention of such harm is recognized as due diligence and an international law principle that is evolving.<sup>34</sup> The borderless nature of certain activities especially in relation to the causation of environmental harm could lead to serious negative effects on at least a state other than the state which the environmental harm arises from.<sup>35</sup> These transboundary environmental problems or harms include the depletion of the ozone layer, global warming, biodiversity loss and oil pollution and they apparently pose a serious challenge to governments and policy makers all over the world.<sup>36</sup> Without doubt, environmental harm is no doubt transboundary.<sup>37</sup> As recently as February, 2017, a sewage interception collapsed in the Tijuana, Mexico and this caused the spillage of over 140 million gallons of raw sewage into the ocean.<sup>38</sup>

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<sup>29</sup> Judith Van Erp et al., *Smart Mixes for Transboundary Environmental Harm*, Cambridge University Press, 2019

<sup>30</sup> UNEP, *Global Environment Outlook 4*. United Nations, 2007

<sup>31</sup> Bodansky, D., Brunnée, J., & Hey, E., *The Oxford Handbook of International Environmental Law*. OUP, 2017

<sup>32</sup> The Trail Smelter Arbitration Case (United States vs Canada) 1941, U.N. Rep. Int'L Arb. Awards 1905 (1949)

<sup>33</sup> Sands, P., Peel, J., Fabra, A., & MacKenzie, R., *Principles of International Environmental Law* (4th ed.). Cambridge University Press, 2018

<sup>34</sup> Akiko Takano, *Due Diligence Obligations and Transboundary Environmental Harm: Cybersecurity Applications*, Graduate School of Global Environmental Studies, Kyoto University, Kyoto available at <https://www.mmpi.com/2075-471X/7/4/36>

<sup>35</sup> Wang Hui, *Transboundary Vessel-Source Marine Pollution-International Legal Framework and its Application to China*, *International Environmental Law and Conventions*, in Michael Faure and Song Ying (eds) *China and International Environmental Liability, Legal Remedies for Transboundary Pollution*, New Horizons in Environmental Law, Edward Elgar, USA

<sup>36</sup> Judith van Erp, Michael Faure, Jing Liu, Markos Karavias, Andre Nollakemper and Niels Phillipsen, *The Concept of Smart Mixes for Transboundary Environmental Harm*, *Smart Mixes for Transboundary Environmental Harm*, Cambridge University Press, 2019

<sup>37</sup> Maria L. Banda, *Regime Congruence: Rethinking the Scope of State Responsibility for Transboundary Environmental Harm*, *Minnesota Law Review*, 3280, 2019

<sup>38</sup> Alex Dobuzinkis, *Cause of Mexican Sewage Spill Fouling U.S Beaches Under Investigation*, Reuters, March 4, 2017 available at <https://in.reuters.com/article/us-usa-mexico-sewage/cause-of-mexican-sewage-spill-fouling-us-beaches-under-investigation-idINKBN16B02R>



The International Court of Justice (ICJ) has no doubt played active roles in the development of the law in relation to transboundary environmental harm.<sup>39</sup> The Case Concerning the Pulp Mills of the River Uruguay represented an opportunity for the ICJ to make pronouncements on issues touching on environmental protection and transboundary pollution.<sup>40</sup> Such other cases that touch on international environmental protection include the Icelandic Fisheries Cases,<sup>41</sup> the Nuclear Tests Cases,<sup>42</sup> the Legality of Nuclear Weapons Advisory Opinion<sup>43</sup> and the Case Concerning the Gabčíkovo-Nagymaros Project.<sup>44</sup> It has been argued that a key rule of international environmental law is that states are obliged not to harm the environment of other states, harm areas extending beyond their domestic jurisdiction.<sup>45</sup>

With the development of technology and industrialization all over the world, some socially desirable activities but which pose inherent danger have been found not to be within the ambit of the prohibition of the law.<sup>46</sup> Thus, from 1978, the International Law Commission (ILC) has given consideration to the topic “International liability for injurious consequences arising out of acts not prohibited by international law.” It has consequently adopted the draft Article on Prevention on Transboundary Harm from Hazardous Activities (draft Articles on Prevention) in 2001 and also adopted the draft Principles on the Allocation of Loss in the Case of Transboundary Damage arising out of Hazardous Activities (the draft Principles) in 2006.<sup>47</sup>

The ILC has since 1980 undertaken the drafting of a comprehensive convention on the liability for damages which arise out of acts not expressly prohibited by international law with transboundary environmental damage being its focus.<sup>48</sup> The sovereignty of states and the fact that states do not have restrictions on their use of natural resources so long as it is within their territory and so long as it does not affect the interests of other states as embodied in principle 21 of the “Declaration of Principles” adopted by the “UN Conference on the Human Environment in 1972.”<sup>49</sup> The development of several concepts to regulate same have not helped matters as the repair of transboundary environmental damage is rarely found.<sup>50</sup>

As a matter of fact, a number of conventions which contain primary liability rules in relation to some specific risk create activities with regard to international maritime, space and nuclear law.<sup>51</sup> Some of these conventions include the Declaration of the United Nations Conference on

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<sup>39</sup> Marte Jervan, *The Prohibition of Transboundary Environmental Harm, An Analysis of the Contribution to the International Court of Justice to the Development of the No-Harm Rule*, Pluri Courts Research Paper No. 14-17, 2014, 1.

<sup>40</sup> James Harrison, *The Role of International Conventions in Solving Transboundary Pollution Disputes, International Environmental Law and Conventions*, in Michael Faure and Song Ying (eds) *China and International Environmental Liability, Legal Remedies for Transboundary Pollution, New Horizons in Environmental Law*, Edward Elgar, USA

<sup>41</sup> (1974) ICJ Reports 3

<sup>42</sup> (1974) ICJ Reports 253 and 457

<sup>43</sup> (1966) ICJ Reports 226

<sup>44</sup> (1997) ICJ Reports 7

<sup>45</sup> Marte Jervan *Ibid*

<sup>46</sup> Gou Haibo, *ILC Proposal on the Role of Origin State in Transboundary Damage, International Environmental Law and Conventions*, in Michael Faure and Song Ying (eds) *China and International Environmental Liability, Legal Remedies for Transboundary Pollution, New Horizons in Environmental Law*, Edward Elgar, USA

<sup>47</sup> Gou Haibo (n.27) 107

<sup>48</sup> Thomas Gehring and Markus Jachtenfuchs, *Liability for Transboundary Environmental Damage Towards a General Liability Regime*, 4 EJIL 1993. 92

<sup>49</sup> Thomas Gehring and Markus Jachtenfuchs *Ibid* at 94

<sup>50</sup> Thomas Gehring and Markus Jachtenfuchs *Ibid* at 94

<sup>51</sup> Thomas Gehring and Markus Jachtenfuchs *Ibid* at 97



the Human Environment (1972 Stockholm Declaration) and the Rio Declaration on Environment and Development. The fact that these Conventions and Declarations exist does not by any means suggest that states had the intentions of being held liable for transboundary environmental damage.<sup>52</sup> The Nuclear Liability Conventions were also created in order to regulate transboundary environmental damage albeit in the nuclear sense.<sup>53</sup> The 1985 Vienna Convention for the Protection of the Ozone Layer,<sup>54</sup> the 1987 Montreal Protocol,<sup>55</sup> and the 1990 London Ozone Conference agreement to amend the Protocol depicted a political will by nations to act collectively and decisively to protect the common future.<sup>56</sup>

The Basel Convention<sup>57</sup> equally makes provisions for global management of hazardous wastes and even though this Convention has been criticized for its flaws,<sup>58</sup> it is viewed as a critical piece of international law efforts in preventing transboundary harm.<sup>59</sup> Despite the best efforts of international law, the fact that there is no broad standard of legal liability for environmental harm for countries has made it difficult for the intended aim to be achieved.<sup>60</sup> It is important to note that the difficulties in implanting and enforcing international law<sup>61</sup> has made environmental regulations less effective and such, despite the multitude of efforts in trying to protect and preserve the global environment such as the 1972 Stockholm Declaration on the Human Environment, the 1987 Montreal Protocol banning the use of Chlorofluorocarbons (CFCs), the 1978 Kyoto Protocol, not much has been achieved.<sup>62</sup>

The United Nations (UN) released a global assessment of the rule of law on environmental law and noted that despite the fact there was increase in the amount of environmental protection agencies and laws, the ability to enforce regulations has made it difficult to achieve the intended aim.<sup>63</sup> The UN has noted the problem of lack of implementation and enforcement is the problem of both international bodies and the states with the latter compounded by the fact that there is no motivation to put into effect such costly regulations and with the fact that there is no guarantee that other states will equally comply.<sup>64</sup>

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<sup>52</sup> Thomas Gehring and Markus Jachtenfuchs Ibid at 97

<sup>53</sup> Jeremy Suttner, Who Pays? The Consequences of State Versus Operator Liability within the Context of Transboundary Environmental Nuclear Damage, 24 N.Y.U. Env't'l L.J. 201

<sup>54</sup> 1985 Convention for the Protection of the Ozone Layer (OJ L 297) 31.10.1988

<sup>55</sup> Montreal Protocol on Substances that deplete the Ozone Layer (OJ L 297, 31.10.1988, pp 8-9)

<sup>56</sup> Sanford E. Gaines, Taking Responsibility for Transboundary Environmental Effects, *Hastings International and Comparative Law*, vol.14 available at [https://repository.uchastings.edu/hastings\\_international\\_comparative\\_law\\_review](https://repository.uchastings.edu/hastings_international_comparative_law_review) accessed 20th May, 2025

<sup>57</sup> The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal

<sup>58</sup> Note, International Law and the Transboundary Shipment of Hazardous Wastes to the Third World: Will the Basel Convention make a Difference? 5 A.M U.J INT'L. & POL'Y.

<sup>59</sup> Andre Nollkaemper, Cluster-Litigation in Cases of Transboundary Environmental Harm, Michael Faure and Song Ying, China and International Environmental Liability, Legal Regimes for Transboundary Pollution, Edward Elgar Publishing Ltd, USA, 2008, 11

<sup>60</sup> James Harrison, Ibid at 38; Wang Hui Ibid at 64

<sup>61</sup> Matus Stulajter, Problem of Enforcement of an International Law Analysis of Law Enforcement Mechanisms of the United Nations and the World Trade Organisation, *Journal of Mod. Sci*, 325

<sup>62</sup> Taylor Kilduff, The Difficulties of Enforcing Global Environmental Law, *The Georgetown Environmental Law Review*, 2019

<sup>63</sup> Environmental Rule of Law First Global Report

<sup>64</sup> Taylor Kilduff, Ibid



#### 4.0 TECHNOLOGY AS AN ENABLER OF ENVIRONMENTAL GOVERNANCE

The growth of technology and the creation of computers have affected every aspect of human life<sup>65</sup> and the administration of justice is no different.<sup>66</sup> The utilization and application of technology have brought about a significant transformation in every aspect of human existence, as it has guaranteed enhanced productivity, effectiveness, and output calibre.<sup>67</sup> In relation to transboundary environmental harm, without doubt, emerging technologies are increasingly seen as instrumental in monitoring, detecting, and managing environmental harm, particularly where traditional regulatory approaches are inadequate.<sup>68</sup> Some technological tools have become imperative to combat this menace including remote sensing and satellite imagery: which allow for real-time monitoring of deforestation, pollution, ocean temperatures, and land-use changes and provide verifiable, independent data that can be used in dispute resolution and cooperative management. There is also AI and big data analytics which can be used to model environmental changes and predict impacts under various scenarios in order to inform policy and foster adaptive governance strategies, blockchain technology which can be used to track emissions, monitor resource use, and create transparent, tamper-proof records for compliance with environmental treaties and Internet of Things (IoT) which can be used to collect data on pollution levels, water usage, and energy efficiency, enabling proactive environmental management.<sup>69</sup>

#### 5.0 EVALUATING CASE STUDIES: TECHNOLOGICAL INTERVENTIONS IN ADDRESSING TRANSBOUNDARY ENVIRONMENTAL HARM

##### 5.1 The Mekong River Basin – Satellite Monitoring and Regional Water Governance

The Mekong River covers six countries namely China, Myanmar, Laos, Thailand, Cambodia, and Vietnam, supporting over 60 million people who rely on its waters for agriculture, fisheries,

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<sup>65</sup> Oluwaseye Oluwayomi Ikubanni and Paul Atagamen Aidonjje, ‘The Legality of Virtual Marriage in Nigeria Given the Covid-19 Pandemic Social Distancing: An X-ray of the Matrimonial Causes Act’ *Madonna University Law Journal* 6.1 (2021), 123-129; Paul Atagamen Aidonjje, Oluwaseye Oluwayomi Ikubanni, and Nosakhare Nkuonghae, ‘The Prospects, Challenges, and Legal Issues of Digital Banking in Nigeria’ *Cogito Multidisciplinary Journal* 14.3 (2022), 186-209, 187

<sup>66</sup> Mohit Ramesh Rao Pise, ‘Significance of Technology in Family Courts: An Analysis’ *Journal of Family and Adoption Law* 4.2 (2021), 1-5; Oluwaseye Oluwayomi Ikubanni, Oluwabusayo Deborah Fajemila, Toluwani David Akinkoye, Sharon Sewa Oluwalana, Ifeoluwa Esther Kolawole, Elizabeth Pohlolis Yakubu, “Protecting the One Earth: An Examination of the Legal and Institutional Frameworks of Environmental Protection in Nigeria” *Nnamdi Azikiwe University Journal of International Law and Jurisprudence* 14.1 (2023), 137-147

<sup>67</sup> Antonio Sanchez-Bayon, “Business and Labour Culture Changes in Digital Paradigm: Rise and Fall of Human Resources and The Emergence of Talent Development” (2020) 12(3) *Cogito Multidisciplinary Research Journal*, 225; Peter E. Egielewa and Paul Atagamen Aidonjje (2021). Media and Law: An Assessment of the Effectiveness of the Freedom of Information Act by Journalists in Nigeria Using Auchi, Edo State as a Case Study, *International Journal of Current Research in Humanities*, Vol. 25, 415-434

<sup>68</sup> Xingyu Li et al., Comprehensive Review of Emerging Contaminants: Detection Technologies, Environmental Impact and Management Strategies, *Ecotoxicology and Environmental Safety Journal*, Vol.28, 2024

<sup>69</sup> Guma Ali et al, Leveraging the Internet of Things, Remote Sensing, and Artificial Intelligence for Sustainable Forest Management, *Babylonian Journal of Internet of Things*, Vol. 2025 (2025). The author particularly argued that “IoT, remote sensing, and AI present transformative potential for improving forest resilience, carbon sequestration, and biodiversity conservation. These technologies are crucial in preserving forest ecosystems and mitigating climate change impacts by advancing real-time monitoring, optimizing resource allocation, and enabling data-driven decisions.”



and transportation.<sup>70</sup> However, large-scale hydropower development, deforestation, and pollution have severely threatened the basin's ecosystem and downstream livelihoods. In a bid to address these challenges, The Mekong River Commission (MRC), which is an intergovernmental organization involving four of the six riparian countries (excluding China and Myanmar), has adopted remote sensing and satellite-based monitoring technologies to track water levels, sediment flow, and land-use changes in near real-time with these tools being perceived as crucial for building trust among member states by providing shared, objective data on river conditions.<sup>71</sup>

The use of remote sensing has aided satellite imagery and GIS mapping thus allowing for real-time updates on dam activity and water fluctuations. Similarly, a shared data portal enhances transparency and enables coordinated response strategies to flooding and droughts.<sup>72</sup> It has been argued that “remote sensing can be used to assess the potential of hydropower resources by analyzing water flow rates and elevation changes. This information can be used to identify areas where hydropower potential is high and to plan hydropower development projects more effectively. The safety of dams and other water infrastructures using remote sensing is vital. This includes structural health monitoring and changes in water levels, detecting seepage or erosion and assessing the stability of the surrounding terrain.”<sup>73</sup>

## 5.2 The Arctic Region – Satellite and AI for Monitoring Climate and Shipping Impacts

The Arctic, a classic example of a global commons, is undergoing rapid transformation due to climate change. Melting ice is opening new shipping routes and exposing untapped natural resources, leading to increased geopolitical interest from Arctic and non-Arctic states alike.<sup>74</sup> This rush for access raises environmental concerns such as pollution, habitat disruption, and ecosystem degradation.<sup>75</sup> To address these threats, the Arctic Monitoring and Assessment Programme (AMAP), under the Arctic Council, has employed advanced technologies such as satellite imagery, AI-driven environmental models, and climate simulation tools to monitor ice melt, pollutant transport, and ecosystem shifts. With the use of technology and AI, AI models predict climate-induced migration patterns of marine species and evaluate shipping impacts on biodiversity.<sup>76</sup> Similarly, satellite monitoring is used to track oil spills, greenhouse gas emissions, and vessel traffic.<sup>77</sup> It has been argued that “remote sensing has been used as an

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<sup>70</sup> Nantana Gajasen, Oliver William Heal and Edwards-Jones Gareth, Chapter 2 The Mekong River Basin: Comprehensive Water Governance,

<sup>71</sup> Guanghui Wang et al, Review Analysis of Irrigation and Application of Remote Sensing in the Lower Mekong River Basin, Special Issue Advanced Satellite Remote Sensing Techniques for Meteorological, Climate and Hydroscience Studies, Remote Sense, 2023

<sup>72</sup> Thanc Duc Dang, The Effect of Water Infrastructure Development in Flow Regimes and Sedimentation in the Mekong River Floodplains, PhD Thesis submitted to the Department of Civil and Natural Resources Engineering, University of Canterbury, Christ Church, New Zealand.

<sup>73</sup> Guanghui Wang et al, Ibid

<sup>74</sup> Kelsey Frazier, Arctic Climate Data Science: The Role of Artificial Intelligence in Supporting Operational Decision Making, Ted Stevens Center for Arctic Security Studies, Special Report, 2023

<sup>75</sup> Kelsey Frazier, Ibid

<sup>76</sup> Kelsey Frazier, Ibid

<sup>77</sup> Wenwen Li, Chia-Yu Hsu and Marco Tedesco, Advancing Arctic Sea Ice Remote Sensing with AI and Deep Learning: Opportunities and Challenges, AI Remote Sensing, 2021.



important vehicle for collecting spatiotemporal information about sea ice properties and conditions in the polar regions.”<sup>78</sup>

It must however be noted that the absence of binding regulations on Arctic shipping routes means that compliance is largely voluntary and this has indeed affected the overall success of the deployment of technology. Similarly, the growing involvement of non-Arctic states increases competition and complicates multilateral governance.

## 6.0 CONCLUSION/RECOMMENDATIONS

With the growth of industrialisation and increased risks of transboundary environmental harm, specific rules ought to be developed to arrest the situation. This is what has been depicted to be the tragedy of the commons using Hardin’s metaphor but despite the best efforts of the international community to commonly tackle the problems, same has indeed been a tall dream in terms of enforcement. There is thus the need for the international community to brace up to challenge the issues which transboundary harm causes on the international community.

It has been shown that commonly held resources are at the risk of being exhausted if concerted efforts are not put in place by the international community to arrest the despairing situation. It is proposed that such concerted efforts should be centred around the use and deployment of AI and technology. Thus, transboundary harm caused by environmental issues are such that can affect the long-term existence of natural resources if depleted. International organisations have sought to arrest the situation but despite the best efforts, much success has not been achieved as a result of the problem confronting international law, enforcement and implementation. In any event, the fact that there are no enforcement mechanisms in international law should not be a bar to compliance as by the principle of *pacta sunt servanda*, agreements entered into must be obeyed. The following are recommended:

1. Strengthen Multilateral Environmental Agreements with Technological Mandates: Thus, international and regional environmental agreements should incorporate explicit provisions for the use of shared technologies, such as remote sensing, AI-based modelling, and blockchain for compliance tracking. This is important because many treaties lack binding clauses requiring states to adopt monitoring technologies or share environmental data. Embedding tech-based obligations into environmental agreements would create accountability mechanisms and foster transparency.
2. Establish Shared Technological Infrastructure and Open Data Platforms: There is a need to develop open-access, interoperable platforms for environmental data sharing that are managed by neutral international bodies, such as the United Nations Environment Programme (UNEP) or regional commissions.
3. Promote Regional Technology Hubs for Environmental Innovation: This can be done by creating regional centers of excellence for environmental technology research and deployment, particularly in areas experiencing acute transboundary harm (e.g., Southeast Asia, Sub-Saharan Africa, the Amazon Basin).
4. Enhance Capacity Building and Technology Transfer to Developing Countries: This can be done by developing targeted funding mechanisms and technical support programs to help developing countries acquire, adapt, and maintain advanced environmental technologies. It must be noted that many of the states most affected by transboundary harm lack the resources to implement technological solutions thus

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<sup>78</sup> Wenwen Li, Chia-Yu Hsu and Marco Tedesco, *Ibid*



implying that equitable access to technology is essential for inclusive participation in global environmental governance and for avoiding further marginalization.

5. **Leverage Artificial Intelligence and Predictive Analytics for Policy Design:** This can be done by integrating AI-driven environmental forecasting tools into international policy formulation to anticipate future risks and evaluate policy impacts in real time.
6. **Insert Environmental Technology Governance in Regional Political Frameworks:** There is a pertinent need to incorporate environmental technology governance into the mandates of regional political organizations (e.g., the African Union, ASEAN, EU), ensuring policy coherence across sectors such as trade, security, and development.
7. **There is a need to institutionalize Real-Time Dispute Resolution Mechanisms:** This can be done by developing tech-enabled early warning and mediation platforms to address disputes arising from transboundary environmental impacts, using real-time data as evidence for dialogue. It must be noted that rapid dispute resolution mechanisms can prevent conflicts from escalating and offer diplomatic alternatives to litigation or retaliation.